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PHYTOPATHOLOGY

VOLUME XII NUMBER 8

AUGUST, 1922

THE RELATION OF TEMPERATURE AND HYDROGEN-ION CONCENTRATION TO UREDINIOSPORE GERMINATION OF BIOLOGIC FORMS OF STEM RUST OF WHEAT[1]

C. R. HURSH

WITH SEVEN FIGURES IN THE TEXT

Although it has been shown that there are numerous biologic forms of *Puccinia graminis* on wheat, which may be differentiated by their parasitic action on certain wheat varieties, the physiologic basis for these differences has never been satisfactorily explained. It has been suggested that their parasitic range may be limited by extremely narrow nutritional requirements furnished by some wheat varieties, but not by others. There has been considerable difficulty, however, in attempting to explain the parasitic action of the biologic forms of the wheat stem rust by this hypothesis. Since the physiology of these forms apart from their hosts has not been studied, and considering the fact that most species and varieties of fungi are known to be quite different physiologically, this study was begun in order to determine whether physiological differences could be demonstrated for the biologic forms of the stem rust of wheat without the aid of differential host varieties.

As the rusts have not been cultivated in artificial media these studies were necessarily confined to spore germination, and while spore germination was not the most desirable attack on such a complex problem, it was nevertheless the only one available. Fortunately it has proved itself to be admirably suited to the problem at hand. The uredinio-spores were selected as the spore forms most suitable for germination studies.

On account of the apparent regional distribution of the biologic forms, which conceivably could be due to temperature relations, the effect of

[1] Co-operative Investigation between the Bureau of Plant Industry of the United States Department of Agriculture and the Agricultural Experiment Station of the University of Minnesota.

Published, with the approval of the Director, as Paper 319 of the Journal Series of the Minnesota Agricultural Experiment Station.

temperature on spore germination was studied. As the behavior of certain species of fungi, in relation to the reaction of a given substrate is known to be specific and characteristic, a study was made of the range of tolerance of biologic forms to hydrogen-ion concentration. Such factors as osmotic concentration of the substrate, influence of specific substances, and various surface-action phenomena also appeared to be worthy of consideration. The experiments reported in this paper, however, deal only with the effect of temperature and hydrogen-ion concentration.

Age and maturity of the urediniospores of wheat stem rust, as well as conditions under which they are developed, and even the conditions to which they are subjected after maturity, all tend to influence germination. Hence in this study it was necessary to eliminate all factors except the one of difference in biologic form alone. This was attempted by using urediniospores of the same age, which were developed under similar greenhouse conditions on Little Club wheat, a host equally susceptible to the biologic forms studied. By using such precautions it was possible to secure constant and uniform results. As a check on the constancy of behavior which could be expected under the conditions of the experiment, germination studies were made on certain forms for a period of over twelve months with the same uniform results throughout the period. During the time the forms passed through at least twelve "urediniospore generations."

MATERIALS AND METHODS

From a number of biologic forms which were studied in preliminary tests, two were selected for further study because of their wide parasitic difference on certain host varieties. One of the forms selected was collected by Professor W. W. Mackie, at El Centro in the Imperial Valley of California, and sent to the Minnesota laboratory for identification. It attacks Marquis, Kanred, Kota, Arnautka, Mindum, Speltz Marz, Kubanka, Acme, and Einkorn quite readily, but it does not produce any infection on White Spring Emmer (Minn. 1165) other than a flecking. The other form was collected by Dr. J. Dufrenoy, at Barègès, France. Of the wheat varieties mentioned, it attacks only Kubanka and Acme in a similar manner to the El Centro strain. On the other hand, it fails entirely to attack either Kanred or Kota, and produces only flecks upon Arnautka and Einkorn. It attacks Marquis, Mindum, and Speltz Marz very weakly, and in contrast to the form from California produces a heavy infection upon Emmer. While such extreme difference in parasitism between two biologic forms is not the rule, it

is quite characteristic of what may be expected in different host reactions with biologic forms of the wheat stem rust. Table 1 shows the parasitic behavior of these two forms.

The temperatures used in these experiments were 10, 20, and 30° C. These were maintained by icebox and control incubators. There was a plus and minus variation of one degree for the two lower temperatures. At 30° C there was practically no variation. In every case germination was studied in a series of solutions which represented a range of hydrogen-ion concentration, thus giving an opportunity to observe the combined influence of temperature and hydrogen-ion concentration. Monobasic acid potassium phosphate was used as a buffer and hydrochloric acid or sodium hydroxide was added. The hydrogen-ion concentration was determined with the potentiometer. Many solutions were actually made up to be at convenient intervals on the pH scale and only those were used which gave a representative range. The method of making up these solutions is given in table 2.

TABLE 1

The effect of Biologic Forms XI and XXVII on differential hosts[1]

Host	Degree of infection	
	Biologic form XI	Biologic form XXVII
Triticum vulgare		
Marquis C. I. 3641	Very heavy	Very weak
Kanred C. I. 5146	do	No infection
Kota C. I. 5878	do	do
Triticum durum		
Arnautka C. I. 4072	do	Flecks only
Mindum C. I. 5296	do	Very weak
Speltz Marz C. I. 6236	do	do
Kubanka C. I. 2094	do	Very heavy
Acme C. I. 5284	do	do
Triticum monococcum		
Einkorn C. I. 2433	do	Flecks only
Triticum dicoccum		
Emmer C. I. 3686	Flecks only	Very heavy
Triticum compactum		
Little Club C. I. 4066	Very heavy	do

[1] These host relations were determined by Dr. E. C. Stakman and Mr. M. N. Levine, Co-operative project between the Office of Cereal Investigations, United States Department of Agriculture and the Division of Plant Pathology, University of Minnesota. The forms had been cultured in the greenhouse at least one year previous to this study.

TABLE 2

Preparation of solutions used for the study of the influence of hydrogen-ion concentration on germination of spores of biologic forms

							pH
1	50 cc	$\frac{M}{5}$ KH_2PO_4	+	$\frac{M}{5}$ HCl	+	water to 200 cc	2.5
2	do	+		do	+	do	3.2
3	do	+		do	+	do	4.2
4	do	+	$\frac{M}{5}$	NaOH	+	do	5.2
5	do	+		do	+	do	6.0
6	do	+		"	+	do	7.0
7	do	+		"	+	do	8.0

In making the germination tests 3 cc. of solution were placed in a clean Syracuse dish, and the spores were placed on the surface of the solution. The dishes were then stacked and incubated for twelve hours. This method was checked against the ordinary hanging drop method and found to be superior. Hundreds of spores can quickly be observed on the surface of the solution in the Syracuse dish in contrast to the much smaller number of spores in the hanging drop. Furthermore the errors introduced through evaporation, distillation of drops, and irregular germination at the margin of drops due to surface action, are obviated by the use of the Syracuse dish.

TABLE 3

The relation of temperature and hydrogen-ion concentration to two biologic forms of Puccinia graminis tritici

	Hydrogen-ion concentration values of pH							Temperature
	2.5	3.2	4.2	5.2	6.0	7.0	8.0	Totals
Form XXVII	Per cent germination							
10 C.....	1	6	34	32	66	15	2	156
20 C.....	6	14	66	91	84	54	8	323
30 C.....	1	3	14	15	33	8	2	72
Average.....	3	8	35	46	61	26	4	
Form XI								
10 C.....	2	29	92	88	91	89	0	391
20 C.....	3	32	96	88	94	78	5	396
30 C.....	2	7	85	75	87	25	7	288
Average.....	2	23	91	84	91	64	4	

RESULTS

The data used in making the accompanying graphs were secured from

three complete series observed on different dates, and from spores of succeeding generations. These data are summarized in table 3. Each figure given as a percentage germination represents a count of 600 spores, being the average of three percentages based on the count of 200 spores for each temperature and hydrogen-ion concentration of three separate series.

Figure 1 shows a comparison of the percentages of germination of the spores of the two forms in a hydrogen-ion concentration range at 10° C. The spores of Form XI germinate in a much wider range of hydrogen-ion concentrations than do the spores of Form XXVII, and

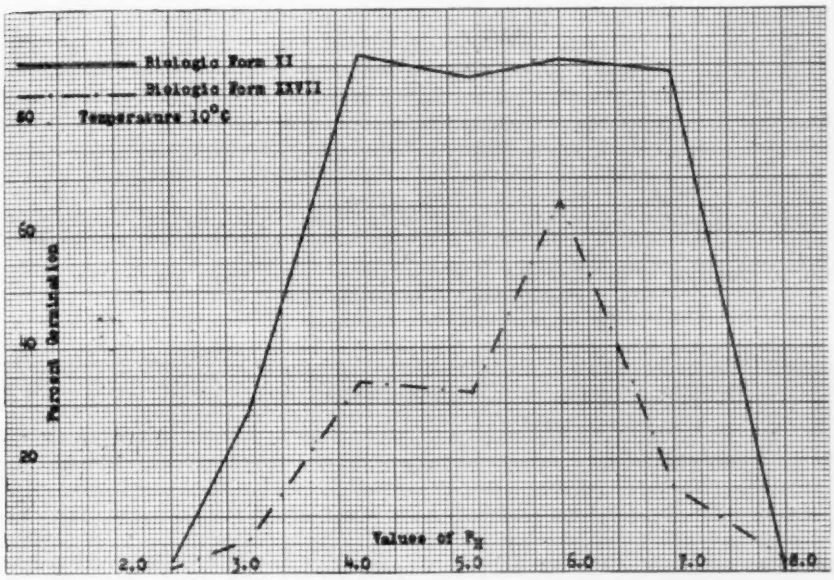

FIG. 1. Relation of hydrogen-ion concentration to urediniospore germination of biologic forms. Temperature 10° C.

the percentage of germination also is consistently higher. Figure 2 shows that at 20° C there is less difference in the behavior of the spores of the two forms so far as maximum germination is concerned, but the spores of Form XI still are more tolerant to the hydrogen-ion extremes. As shown by figure 3, the tolerance of the spores of Form XI decreased at 30° C, whereas the germination of the spores of Form XXVII is decidedly inhibited throughout by this higher temperature. Figure 4 permits an easy comparison of the effect of temperature on the behavior of Form XI in the hydrogen-ion concentration range, and figure 5 shows

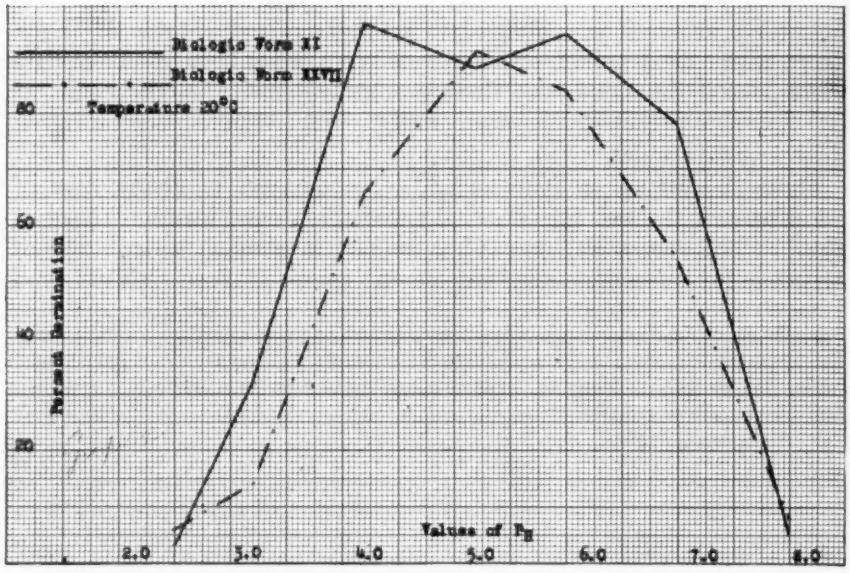

FIG. 2. Relation of hydrogen-ion concentration to urediniospore germination of biologic forms. Temperature 20° C.

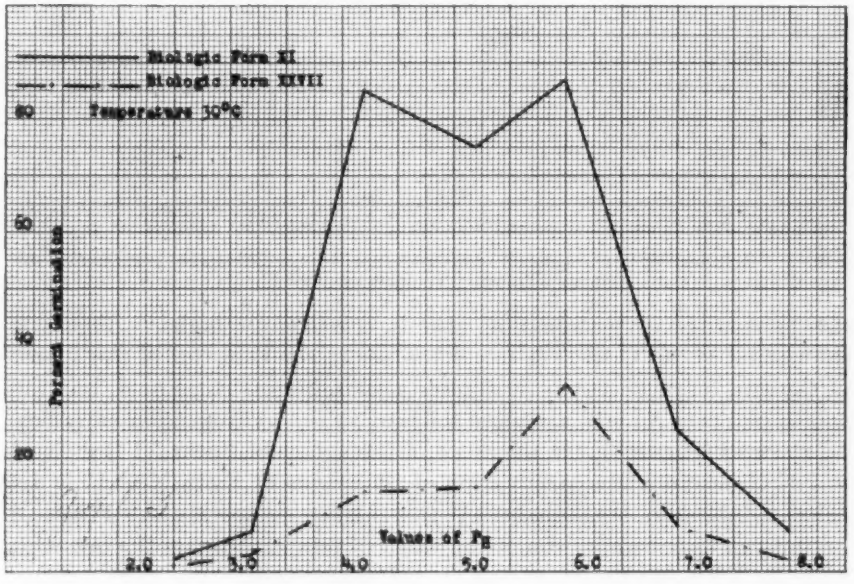

FIG. 3. Relation of hydrogen-ion concentration to urediniospore germination of biologic forms. Temperature 30° C.

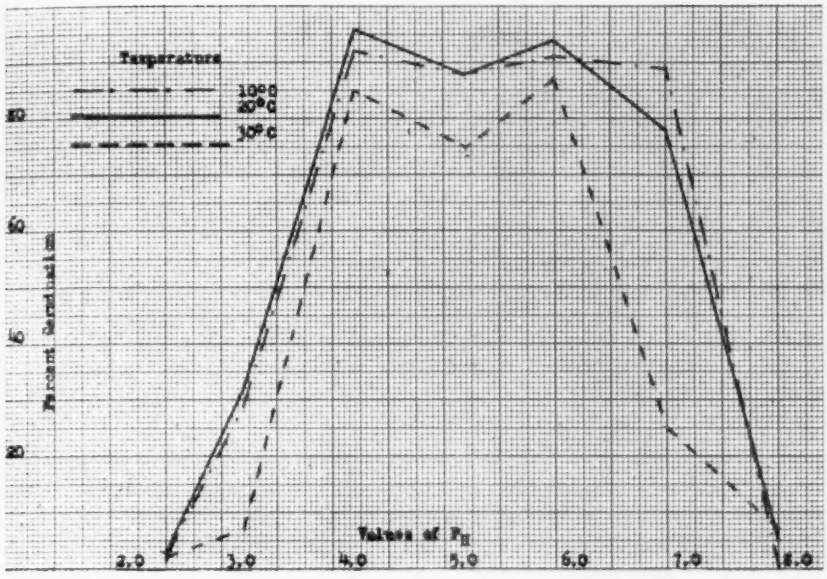

FIG. 4. Relation of temperature and hydrogen-ion concentration to urediniospore germination of Biologic Form XI.

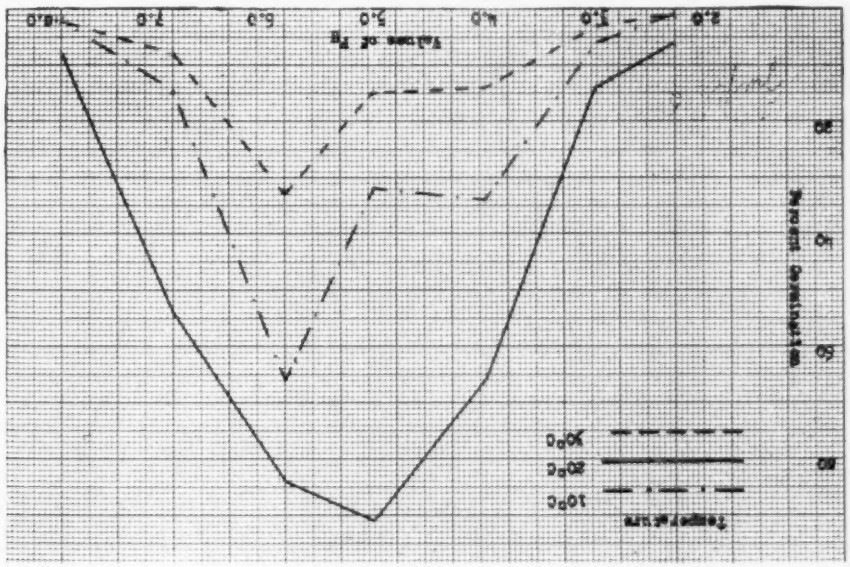

FIG. 5. Relation of temperature and hydrogen-ion concentration to urediniospore germination of Biologic Form XXVII.

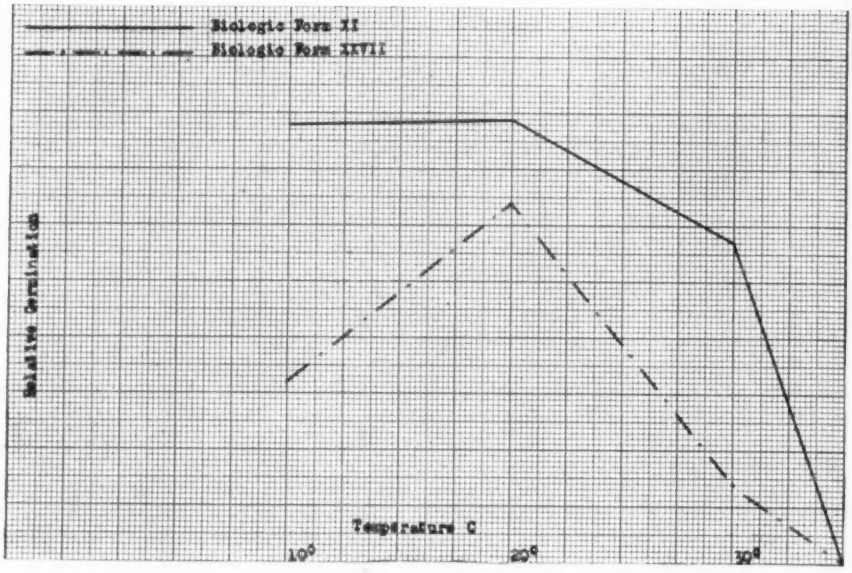

FIG. 6. Relation of temperature to urediniospore germination of biologic forms.

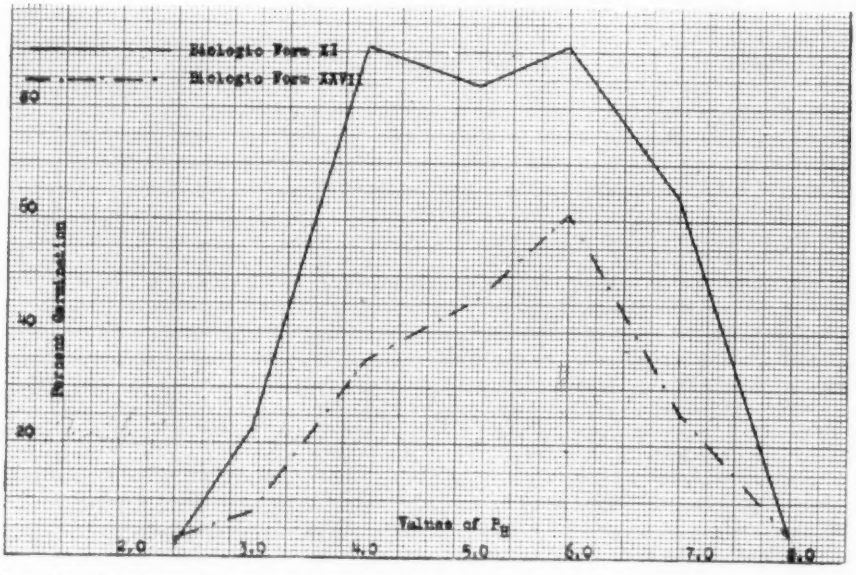

FIG. 7. Relation of hydrogen-ion concentration to urediniospore germination of biologic forms.

the analagous data for Form XXVII. Figure 6 summarizes the data secured for the two forms, considering temperature only, and in a similar way figure 7 summarizes the influence of the hydrogen-ion concentration of the solution.

In the data presented there appears to be a positive correlation between limited host range and restricted tolerance of the germinating urediniospores to temperature and hydrogen-ion concentration. Whether this correlation may be of significance in a study of resistant hosts is a problem for further investigation. In general these data show that the genetic constitution of two biologic forms of stem rust of wheat is essentially different in each form. It would appear that biologic forms differ from one another in their capacity for physiologic behavior and this in turn determines their action on differential hosts.

SUMMARY

In summarizing this preliminary report the following facts seem to have been established.

1. Two biologic forms of *Puccinia graminis* of wheat, differing in their parasitic behavior, show a considerable difference in germination response to temperature and hydrogen-ion concentration.

2. The form more limited in its host range is also more restricted in tolerance of extremes of hydrogen-ion concentration and temperature.

3. The differentiation of biologic forms is not entirely dependent on their parasitic behavior on certain host plants. At least some biologic forms apparently possess individual physiologic characteristics demonstrable by physical and chemical studies, and these characteristics alone may be sufficient to establish them as definite taxonomic entities.

NOTES ON CHEMICAL INJURIES TO THE EASTERN WHITE PINE (PINUS STROBUS L.)

WALTER H. SNELL AND NATHANIEL O. HOWARD

WITH PLATE XXIV AND TWO FIGURES IN THE TEXT

INTRODUCTION

Injuries to the eastern white pine (*Pinus strobus* L.) are often very conspicuous because of the contrast in color between the yellow-green, red or brown-red needles of injured portions and the bright green of the normal foliage. As one travels through white pine country he notices many such discolorations which challenge his interest and demand explanation. Outside of the single branch injuries which may be due to mechanical causes, to the white pine blister rust fungus (*Cronartium ribicola* Fischer), or to certain insects such as the pine weevil (*Pissodes strobi* Peck), and pine bark louse (*Chermes pinicorticis* Fitch), there are many troubles which affect the entire tree. Of these general disturbances indicated by the conspicuous deviations from the normal fresh green color of the foliage and popularly called "blights," there may be mentioned the following which in each case can be traced to some definite cause: 1, a bronzed appearance of the foliage of entire trees over large areas due to the annual dying of the older needles; 2, the common spring "blight" of the foliage of entire trees or of portions of trees, commonly on the side of the prevailing winds and sometimes observable over extensive areas, caused by winter drying; 3, the death of tops or of other comparatively large portions of good sized trees, or of entire trees in the case of the smaller ones, noticeable in more restricted areas and caused by *Cronartium ribicola* Fischer; 4, the death of numerous trees in more or less localized areas in pine lots due to the root-rotting fungus, *Armillaria mellea* (Vahl.) Quel.; 5, the occasional death of trees in swampy regions due to drowning, i. e. lack of proper aeration of the roots. In addition to these one often observes trees with diffuse red-brown foliage, sometimes alone, often in groups and either dead or still alive, the condition of which defies a ready diagnosis. This paper gives observations made during the summer of 1921, upon the reddening of white pines due to two entirely different causes but both of a chemical nature.

INJURY CAUSED BY TOXIC FUMES

The first type which was observed in eastern Massachusetts during the early part of August was characterized by a reddening of the foliage of white pines *en masse* over an area perhaps ½ mile long by ¼ mile wide at the broadest point and appearing even at a distance of two or

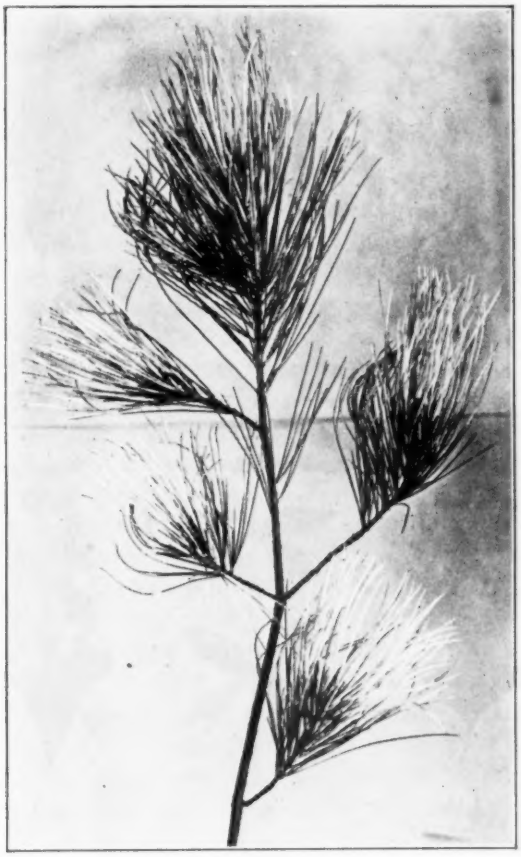

FIG. 1. Branch of white pine showing the effect of acid fumes. The lighter colored portions of the needles were dead and reddish brown, while the dark portions were still green and living.

three miles as a rich red blotch in the general landscape. At a distance of a few yards the needles seemed to be entirely dead, so evenly diffused was the red color of the foliage. A close examination of the twigs, however, revealed the fact that all of the needles were not dead and that the trees were still alive (Fig. 1). The younger needles appeared to

have suffered most, though nearly all were discolored to some extent. Further examination of the trees in this area disclosed the fact that not only the pines, but also many of the deciduous trees, i. e., black oak (*Quercus velutina* Lam.), white oak (*Quercus alba* L.), swamp white oak (*Quercus bicolor* Willd.), gray birch (*Betula populifolia* Marsh.),

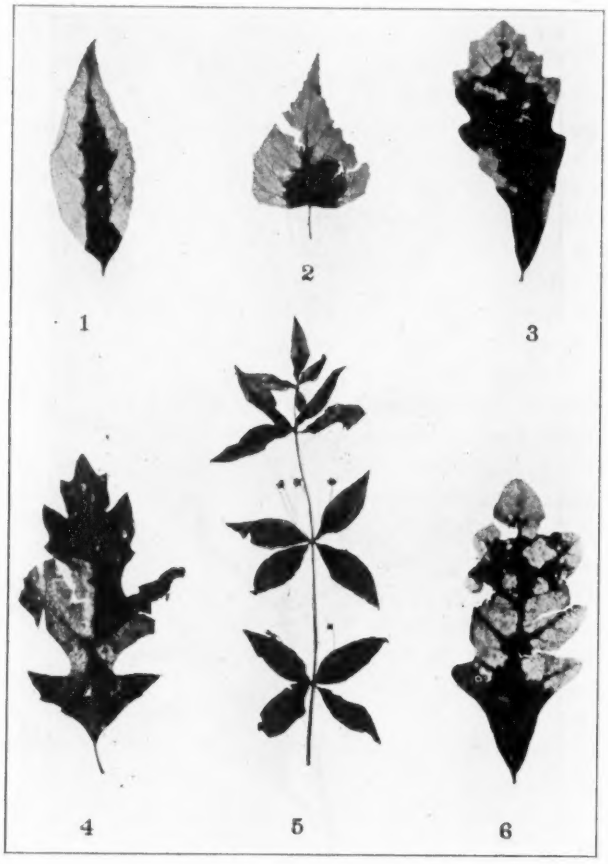

FIG. 2. Various leaves from the discolored area showing the effects of the acid fumes in the marginal blanching. 1, Black cherry (*Prunus serotina* Ehrb.), 2, Gray birch (*Betula populifolia* Marsh), 3, Swamp white oak (*Quercus bicolor* Willd.), 4, Black oak (*Quercus velutina* Lam.), 5, Whorled loosestrife (*Lysimachia quadrifolia* L.), 6, White oak (*Quercus alba* L.).

wild black cherry (*Prunus serotina* Ehrb.), and even such plants as poison ivy (*Rhus toxicodendron* L.), whorled loosestrife (*Lysimachia quadrifolia* L.), and brake (*Pteris aquilina* L.) bore evidence of injury. In the majority of these cases the damage was manifest in the marginal browning or blanching of the leaves (Fig. 2). It is of interest to note

that hickory (*Carya sp.*), elm (*Ulmus americana* L.), and blue spruce (*Picea pungens* Engelm), however, were apparently unaffected. The limits of the diseased area were well defined, this being particularly true of the western border. Norway spruces (*Picea excelsa* Link.) lying just within the borderline bore many reddened leaves, while those but a few feet further to the west and apparently outside of the zone were perfectly normal.

According to certain persons living or working in the immediate vicinity, this type of injury has appeared in identically the same spot during the early part of the past two summers. In each instance it was noted that the majority of the trees recovered and developed normal foliage. Occasional trees, however, succumbed. Another lot of pines lying approximately ½ mile to the northeast had been so badly injured during previous years that it was found necessary to fell them.

Because of the strikingly localized character of the affection, one naturally sought the cause in the immediate vicinity. Three possible sources only were found: i. e., a railroad paralleling the diseased area on the east, a power plant three quarters of a mile to the northeast, and a brick kiln but a few hundred yards to the north. After a thorough investigation the first was eliminated, for it was observed that trees outside of the discolored area, yet between it and the tracks were unaffected. The power plant seemed to be too far removed to be considered responsible for the injury, though a careful study of the drift of smoke issuing from the tall stack was made. Suspicion pointed strongly toward the fumes from the brick kiln. This kiln is located at a point 300 yards north of the discolored area and perhaps 120 yards from the nearest pine. Furthermore, the affected trees lay in a more or less fan-shaped area with the apex pointing directly toward the kiln to the north. Finally, it was observed that the intensity of the discoloration varied with the distance from the kiln, it being most conspicuous at the apex of the fan-shaped area and gradually diminishing towards the limits farthest from the kiln. If it could be proved that toxic fumes had emanated from the kilns within the preceding few weeks and that prevailing winds during that time had favored a drift of these fumes toward the pines, an explanation of the phenomenon would be found. Inquiries were made at the office of the brick yard and records of kiln burnings were studied. It was learned that the burnings lasted for 9 days each with quiescent intervals of 2–9 days during which the fires were extinguished and the bricks removed. It is the custom to use bituminous coal in the arches of the kilns during each burning, and usually during the last three or four days. This material is placed upon the burning wood, the customary fuel, in order "to draw the fire." It

is probable that acid fumes resulting from the combustion of coal of relatively high sulphur content were carried to the pines by north, northwest or northeast winds and brought about the phenomenon here described.

Records of the local station of the weather bureau for the two months immediately preceding were examined. Table 1 shows the relation of the time of the appearance of the discoloration to the periods of kiln burning and to certain meteorological data.

TABLE 1

The relation of the time when the discoloration of the pines was first observed to the periods of kiln burning and to certain meteorological data

Dates of kiln burning	Direction of wind	Temperature degrees F	Relative humidity percentage	Precipitation In.	Condition of pines
June					
8	SW–S	68	86	0.	Good
9	SW–S	68	85	0.	ditto
10	SW–S	67	84	0.	"
11	SW–S	67	87	0.	"
12	W–W	80	86	0.	"
13	SW–SW	69	87	0.	"
14	NW–N	65	84	0.	"
15	NW–N	67	84–90	.03	"
16	NW	66	84–86	0.	"
17	NW–SW	68	84–86	0.	"
28	SW–NE	73	95–96	.01	Good
29	SW–NE	72	91–90	.18	ditto
30	N	63	100	3.00	"
July					
1	N–NE	61	100	.37	"
2	N–NW	61	100	1.13	"
3	SW–E	74	86–88	.03	"
4	NW–NE	82	88	1.22	"
5	NE–E	72	85–88	0.	"
14	SW	84	86–88	0.	Good
15	SW-NE	76	86–100	.08	"
16	NE	68	85–86	.24	Reddening first reported
17	SW-S	74	87–86	0.	" increasing
18	SW	73	86–87	0.	ditto
19	SW	74	81–87	0.	"
20	NW–N	77	91–94	.33	"
21	NE	65	94–86	.07	"
22	NW–NE	69	85–86	0.	"
23	NE	70	85–87	0.	Reddening pronounced

It will be observed that during the latter part of each period of kiln burning, i. e. during those days when coal was being used as part fuel, the wind blew from a general northerly direction. This would carry the gaseous products of combustion toward the pines. These data then harmonize fairly well in the support of the hypothesis that such fumes arising from the arches of the kilns were directly responsible for the injury, especially when taken into consideration with the following facts noted previously:

1, the distinctly localized character of the injury;

2, the striking fan shape of the area, with the apex pointing toward the kiln;

3, the gradual decrease in the intensity of the discoloration toward the limits farthest from the kiln;

4, the sharp lateral delimitation of the area;

5, the injury to broad-leaf trees, herbaceous plants and ferns as well as to the conifers, within the same area.

Abundant evidence can be found to support the statement that sulphur dioxide will cause the discoloration of pines. It is difficult to state however, without experimental data the exact time of the initial attack in this particular instance. In all probability the effect was cumulative.

INJURY DUE TO A CHEMICAL SUBSTANCE IN THE SOIL

The second case of chemical injury was the reddening of the foliage and death of individual pine trees along a roadside in New Hampshire (Pl. XXIV). Trees of all sizes were affected. Those under 6 inches in diameter were killed and the mature pines either had large portions of the crown entirely killed or suffered the killing of parts of the needles more or less generally. The redness of the needles was hardly distinguishable from that resulting from fumes and referred to above. The cause was found to be a very simple one. Along this particular gravel road, calcium chloride, a hygroscopic salt, had been applied to the surface to act as a binder and thus prevent dust. This was the only treatment which the road has received for several years. Preparatory to the application of the calcium chloride, the metal containers had been distributed along the roadside at intervals and were placed in the majority of cases under pine trees. These barrels were not tight because of rough handling and the chemical either fell out directly in the dry condition or was dissolved out by the water which it had absorbed from the air. The barrels remained by the roadside for about a month (May 15 to June 15, roughly) during a period when the rainfall was very slight.

It would seem, then, that little of the salt could have been dissolved by other than the absorbed water. However, a sufficient amount of it seeped into the soil and caused the damage stated.

That the calcium chloride was the cause of the damage appeared evident inasmuch as every tree under which barrels had been placed was affected. Trees with barrels near the trunks were killed and those with barrels at a distance from the trunk yet within the limits of the root system suffered partially (Pl. XXIV). Other pines along the road for miles were in the best of condition.

The pines were not the only trees injured, for both birches and elms under which barrels of calcium chloride had been stored, suffered more or less severely. The injury to the deciduous trees consisted of the marginal drying and browning of leaves, together with a pronounced upward curling of the leaves and partial defoliation of the upper branches in the case of the elm. No killing of these trees was noted however. As in the case of the pines those deciduous trees with no barrels of calcium chloride at the base were in a healthy condition.

It may be added that common salt used upon roadways and walks for a similar purpose has been known to affect bordering trees, particularly maples, in much the same manner.

SUMMARY

This paper gives observations made during the summer of 1921, upon the reddening of the white pine due to two entirely different causes, but both of a chemical nature.

1. A very conspicuous reddening of white pines in a limited area, perhaps ½ by ¼ mile was observed in eastern Massachusetts. This injury apparently was caused by acid fumes emanating from the arches of a near-by brick kiln, wherein coal was occasionally used as fuel.

2. The reddening of pines along a road in New Hampshire was observed. This was found to be due to calcium chloride which had leached from barrels placed under pines by the roadside.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
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In co-operation with the Department of Botany,
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INJURIES TO WHITE PINE

Pine trees with discolored foliage caused by calcium chloride which seeped into the soil from barrels placed beneath the trees. The smaller one is entirely dead and the nearer portions of the larger tree above the smaller one may be seen to be dead.

UNIV. OF MICH.

TORULA LIGNIPERDA (WILLK.) SACC.
A HYPHOMYCETE OCCURRING IN WOOD TISSUE

PAUL V. SIGGERS

WITH PLATE XXV

Late in 1919 there were received at the Forest Products Laboratory, Madison, Wisconsin, a shipment of white ash (*Fraxius americana* L.) logs from Graham County, Tennessee and a shipment of yellow poplar (*Liriodendron tulipifera* L.) logs from east central Kentucky. After remaining a few weeks in a well-ventilated pile, the logs were cut into standard sizes for use in standard timber tests. When these tests were conducted the variation in strength values obtained, as compared with the values which would be expected in normal white ash and yellow poplar, suggested an examination of the test pieces for evidence of fungous infection.

The test pieces had been selected carefully and would ordinarily have been considered sound, but examination showed dark catenulate spores scattered deeply in the wood of both species.[1] The spores were similar in both cases. Further study showed that the fungus was present in the heartwood, sapwood, and throughout the length of the white ash logs. In the ash test pieces the presence of the fungus was correlated with dark tan streaks which had a tendency to follow along the same group of annual rings. In cross section the discoloration appeared in more or less irregular zones. In the case of the yellow poplar the fungus was not so widely distributed as it was in the white ash, but in all cases where the wood showed a reddish pink tinge, the dark spores could be found easily. The color variation normally present in yellow poplar, from the greenish yellow, so characteristic of the wood, through the various darker colors, tended to mask any early stages of color change due to the fungus.

A number of transfers were made to agar in test tubes from the streaks in several blocks of yellow poplar. In two tubes out of thirty a dark slow growing fungus developed. All of the other twenty-eight tubes remained sterile. An examination of the fungus both in the cultures and in the wood showed the two to be identical.

[1] Miss Gertrude Griffin of the Forest Products Laboratory made the original microscopic examination, brought the fungus to the writer's attention and kindly translated a portion of Willkomm's "Die Mikroskopischen Feinde des Waldes."

The writer wishes to acknowledge also help received from R. H. Colley and E. E. Hubert in the preparation of the manuscript and photomicrographs.

A few weeks later the writer's attention was directed to a similarity between the fungus in the tube cultures and one noted by von Schrenk (8) as occurring, among others, in the wood known as "pecky" cypress. He called it *Xenodochus ligniperda*. The original description of *Xenodochus ligniperda* was published by Willkomm (9). He reported having observed spores of this fungus in spruce, fir, oak, buckthorn (*Rhamnus cathartica* L.), and french briar (*Erica arborea* L.). He believed the organism was responsible for what he called "red rot"; but, in the light of present day knowledge of the subject of wood decay, Willkomm's "red rot" was probably due to one of the higher fungi. He associated *Rhyncomyces violaceus* with *Xenodochus ligniperda* and asserted that the former had its origin in an alleged motile stage of the latter. He considered that the fungus was also related to Th. Hartig's *Nyctomyces fuscus* —a sterile form. Willkomm's drawings are very good, but the variety of fungi described forces the conclusion that he was dealing collectively with a large number of organisms. It is unfortunate that the technique of fungus isolation had not been developed at the time Willkomm did this work. R. Hartig (3) considered the fungus a Pyrenomycete. He often observed it in the roots of trees in association with *Armillaria mellea* and concluded that the organism was apparently able to penetrate cell walls. Saccardo (5) listed the fungus as *Torula ligniperda*, and as such it is referred to in this article. Sorauer (7) reviewed Willkomm's work several years later but made no original observations.

Members of the Torula group have been known for a long time as wood-inhabiting fungi. They have been noted as the cause of sooty or blackish discolorations on dead branches of woody and herbaceous plants and on pine timber which had been exposed to the weather. A few years ago, Miss Smith (6) isolated from partially decayed house timbers several Hyphomycetes, including Torula and Haplographium. She concluded that favorable conditions of moisture made possible the development of these forms in wood, and that under such conditions they accounted for its slow decay.

Torula ligniperda was found in red gum in 1911 by Dr. Eloise Gerry. This is the first record, so far as can be determined, of the appearance of the fungus in wood specimens examined at the Forest Products Laboratory. Since this study was begun, it has been found by E. E. Hubert forming dark bands running longitudinally with the grain of the wood in eastern hemlock (*Tsuga canadensis* Carr.), usually on the outer edge of the region of incipient decay of a brown cubical rot. It has also been found in basswood veneer and in maple furniture stock.

Several tests were started to determine if possible how the power of

this fungus to attack wood compared with that of Basidiomycetes. Small cubes of sapwood and heartwood of yellow poplar, none of which exceeded a cubic centimeter in volume and which had previously been immersed in water, were placed over moist cotton in large test tubes. They were then sterilized without pressure. Inoculation by transfer from pure cultures of the fungus was made March 26, 1920. Sixteen tubes were prepared; fourteen were inoculated and two were held as controls. The wood blocks were under observation for six months and the progress of the fungus from block to block was noted. In October, 1920, two of the tubes were opened and a representative block from each was sectioned and stained after the method outlined by Colley (1). Plate XXV, figure 2, shows the spore chain of *Torula ligniperda* distributed in the vessels, medullary rays and wood fibers of yellow poplar. Figure 5 plate XXV illustrates the manner in which the mycelium and spores follow the length of the cell. Microscopic examination of these stained sections showed clearly small hyphae passing through the cell walls, but as the safranin used in the stain colored both the tissue and the fungus more or less uniformly it was not possible to get a photograph which showed the penetration satisfactorily.

In addition to the tests described above a durability test was run for approximately six months, using essentially the method followed by Humphrey (4). At the end of the test, the blocks were split longitudinally and radial sections were made of the tissue in the middle of each block. Rapid microscopic examination of these sections was possible because the dark catenulate spores always contrasted strongly with the lighter wood tissue, and though no actual spore count was attempted, it was comparatively easy to determine the relative abundance of spores in the woods tested. The results of the examination are shown below.

Yellow poplar heartwood	Spores scattered sparingly in all blocks.
White ash heartwood	Spores distributed generally in all tissues of all blocks.
Cypress heartwood	Spores scattered sparingly in two out of four blocks.
Cucumber tree sapwood	Spores heavily distributed in all tissues of all blocks.
White ash sapwood	Spores heavily distributed in all tissues of all blocks.
Cypress sapwood	Spores scattered sparingly in all blocks.

The loss of weight in the infected blocks can only be stated in general terms. The test was evidently too short but, unfortunately it had to be discontinued. Sapwood lost more weight than heartwood by approximately 50 per cent in the yellow poplar and white ash blocks. In cypress the loss in heartwood and sapwood was about the same.

The fungus has been growing on a number of different kinds of nutrient agar for half a year and while sclerotial bodies have apparently developed there is not enough of this material to determine what these bodies are. It is a slow growing fungus. Optimum conditions for mycelium development appear to be 27° C. in darkness and, given these conditions, it has averaged 1 mm. a day for four weeks on 2.5 per cent malt extract agar.

Unfavorable physiological conditions, probably due to prolonged growth of the organism in the same culture or to a gradual drying up of the agar have repeatedly resulted in the production of spore groups of three and two, and even single spores; that is, under these unfavorable conditions the catenulate form disappeared. The size of the spore chain based on the measurement of ten mature spores is 10.5 to 12.7 by 45 to 72 microns. Figure 4, Pl. XXV shows a number of short spore chains taken from the margin of a Petri dish—a culture six months and fourteen days old. The hyaline spores are immature forms. In the figure, a number of simple unbranched conidiophores illustrate the common type of spore attachment. At "c" figure 4 Pl. XXV there is shown a slight constriction of the lateral hypha at the point of attachment. Another mycelium characteristic, a slight swelling of the hyphal joints, has been frequently observed, although it would appear that this is not a specific characteristic for the fungus, for Ellis and Bartholomew (2) describe subglobose joints in the hyphae of *Torula brachiata*. The comparatively sparse growth of mycelium in figure 4 Pl. XXV is characteristic of growth in attenuated cultures. Figure 1 Pl. XXV shows a number of four to six spore chains taken from the central part of the same culture as that from which the spores in figure 4 were taken, but which had developed at a period when the fungus was in full physiological vigor. The globose cell in the group in figure 3 is an abnormality which appears to be induced by retention of the fungus for a long time in the same culture. An interesting development in cypress test blocks of many short two and three spores chain suggest that cypress is a physiologically unfavorable medium.

Analysis of the results of the mechanical tests made on the yellow poplar and white ash described at the beginning of this paper, and careful comparison of the values obtained with sound and infected test pieces, showed that—

(a) In the case of the yellow poplar, it was practically impossible to correlate the differences in these results with the presence or absence of the fungus; but that

(b) in the case of the white ash all the infected logs except one "had a lower specific gravity than the average specific gravity of the sound logs; logs in which infection was found with difficulty showed little decrease in strength; and logs in which infection was readily found showed a marked decrease in strength values."[1]

Two points should be borne in mind in considering the above statements: first, that it was impossible to determine by means of culture tests whether or not any other fungus besides *Torula ligniperda* was present in the ash test pieces, because the ash had been kiln dried; and second, that *Torula ligniperda* has been reported by Willkomm, R. Hartig and von Schrenk (loc. cit.) as a concomitant of wood-destroying fungi, and observed in this laboratory associated with a brown cubical rot in eastern hemlock. *Torula ligniperda* was easily found in the ash by microscopical examination because the spores are typical. Hyphae of other fungi, had they been present, could not have been distinguished from the hyphae of *Torula* without culture tests, and it was impossible to make culture tests as pointed out above. Reduced to its simplest form the conclusion to be drawn from this discussion is that white ash, with plenty of evidence of the presence of fungous hyphae, but little or no evidence of breaking down of the wood cells, did show lower strength values than white ash in which no mycelium could be found.

SUMMARY

Torula ligniperda (Willk.) Sacc., a wood-inhabiting Hyphomycete, has been found in nature by various investigators in spruce, fir, oak, buckthorn, french briar, cypress, yellow poplar, maple, basswood, eastern hemlock, white ash and red gum. In the laboratory it has been grown in cypress, white ash, yellow poplar and cucumber tree.

The hyphae of the fungus, although usually running in the lumens of the wood cells, may occasionally penetrate the cell walls.

White ash logs heavily infected with *Torula ligniperda* showed a decrease in strength values as compared to values obtained from logs in which no infection could be found.

Culture studies have so far yielded no perfect form of the fungus.

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[1] Data supplied by Mr. R. F. Luxford of the Forest Products Laboratory.

LITERATURE CITED

(1) COLLEY, R. H. Diagnosing white-pine blister rust from its mycelium. Jour. Agric. Res. **11**: 281–286. *Fig. 1, pl. 31.* 1917.

(2) ELLIS, J. B. and BARTHOLOMEW, E. New species of fungi from various localities. Jour. Mycol. **8**: 173–178. 1902.

(3) HARTIG, ROBERT. Die zersetzunserscheinungen des Holzes der Nadelholzbäume und der Eiche. Berlin. 1878.

(4) HUMPHREY, C. J. Laboratory tests on the durability of American woods. I. Mycologia **8**: 80–92. *Pl. 183.* 1916.

(5) SACCARDO, P. A. Sylloge Fungorum **18**: 565–566. 1906.

(6) SMIYH, A. L. Hyphomycetes and the rotting of timber. Trans. British Mycol. Soc. **6**: 54–55. 1918.

(7) SORAUER, PAUL. Handbuch der Pflanzenkrankheiten. 1st ed. 406 p., 16 pl. (partly col.). Berlin, 1874.

(8) VON SCHRENK, HERMANN. A disease of *Taxodium distichum* known as peckiness, also a similar disease of *Librocedrus decurrens* known as pin-rot. Missouri Bot. Gard. 11th Ann. Rept. p. 23–77. *Pl. 1–6 (partly col.).* 1900.

(9) WILLKOMM, MORITZ. Die mikroskopischen Feinde des Waldes. Erstes heft. *Pl. 1–14, fig. 1–7.* Dresden. 1866.

DESCRIPTION OF PLATE XXV

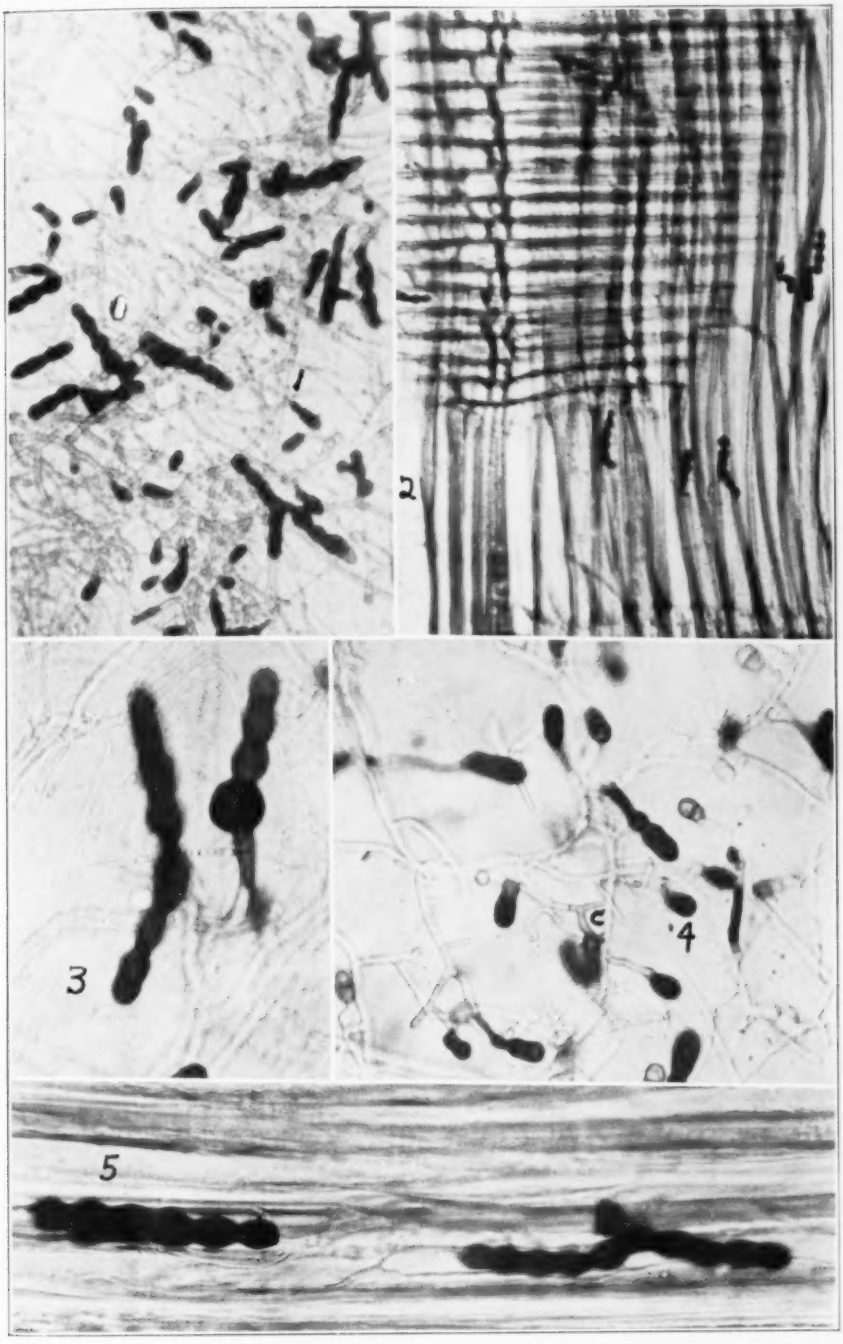
Fig. 1. Long four to six celled spore chains of *Torula ligniperda* produced near the center of a petri dish culture six and a half months old. × 180.

Fig. 2. Normal spore chains of *Torula ligniperda* dustributed in the vessels, medullary rays and wood fibers od *Liriodendron tulipifera.* × 120.

Fig. 3. Globose cell in the spore chain—apparently a physiological reaction occurring when the fungus has been for a long time in the same culture. × 525.

Fig. 4. Short spore chains and hypertrophied mycelium obtained from the edge of a petri dish culture six and a half months old. × 270.

Fig. 5. Mycelium and three spore chains of *Torula ligniperda* following the length of the cells in *Liriodendron tulipifera.* × 500.



TORULA LIGNIPERDA (WILLK.) SACC.

LEAF SCORCH OR MOLLISIOSE OF THE STRAWBERRY[1]

R. E. Stone

With Three Figures in the Text

The cultivated strawberry is subject to several leaf diseases. The best known of these diseases is the leaf spot due to the fungus *Mycosphaerella fragariae* (Schw.) Lindau. There are several other leaf diseases, as leaf blight, leaf blotch and leaf scorch. In the Province of Ontario a serious leaf disease is present in many fields. The disease has been named leaf scorch on account of the characteristic dry brown appearance of the leaves of the badly diseased plants (1). The name Mollisiose has also been applied (1). This disease has been observed in southern Ontario, the Niagara Peninsula and also in eastern Ontario. It has also been reported from several of the states in the United States.

SYMPTOMS OF THE DISEASE

In the early part of the season, May, the strawberry leaves show irregular purple blotches ranging in size from ⅛ to ¼ inch in diameter. There may also be purple stripes on the petioles and on flower peduncles. In this stage the disease resembles the early stage of "leaf spot" but the blotches are much more irregular. As the season advances the blotches enlarge and coalesce. In time the whole leaf may be involved. As the blotches increase in size they become grey or cinereous, with a purple border. Later the definite border disappears. When the blotches have become dry and cinereous the dark acervuli become prominent, scattered thickly over the surface. As the disease progresses all the leaves on a plant take on a dry burned appearance (Fig. 1). It is not uncommon in July and August to find strawberry beds which have the appearance of having been burned over. Leaf scorch is seldom very prominent in new plantings except on a few plants, as any plant showing pronounced indications of the disease is usually discarded. However, where susceptible varieties are being used most of the plants will show some blotches before the end of the season. The next spring the disease appears very early and may be quite serious before the crop is picked. After the harvest the disease progresses very rapidly and all the leaves may be dry and cinereous by July or August. The diseased plants do not winter well and the crop may be very short the second year.

[1] Contribution from Botanical Department, Ontario Agricultural College, Guelph, Ontario.

VARIETAL SUSCEPTIBILITY

Not all varieties are equally susceptible to the disease. In fields where several varieties are being grown the difference in the susceptibility of the different varieties is very marked. One variety may be badly affected while another may show scarcely any disease. It is not unusual for a grower to have two or more varieties in his plantings so that several varieties may be directly compared. From a study of plants in the field the common varieties may be arranged in the following order.

Very susceptible	Moderately susceptible	Slightly susceptible
Clyde	Senator Dunlop	New Williams
Glen Mary	Ruby	Portia
Doctor Burrill	William Belt	Parson's Beauty
Pokomoke		Enhance
		Vanoise
		Joe

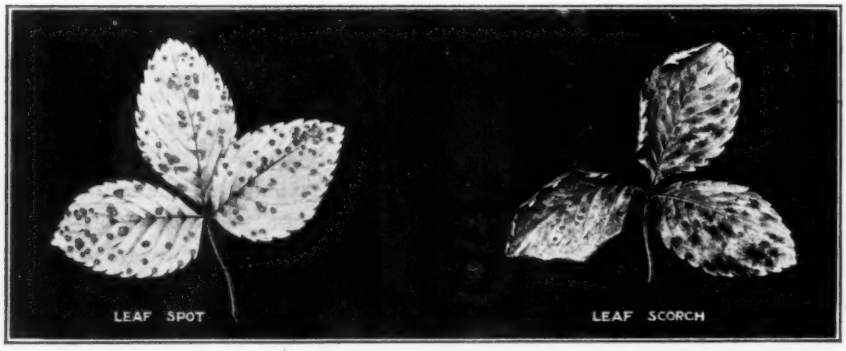


FIG. 1. A drawing showing the difference in the appearance beween "leaf spot" and "leaf scorch."

CAUSAL ORGANISM

An examination of the cinereous portions of leaf blotches and diseased petioles reveals the presence of dark acervuli which are filled with hyaline two-celled spores. The fungus agrees with the description of *Marsonia potentillae* (Desm.) Fischer, and also agrees with exsiccati specimens of this fungus.[1] The fungus can be grown readily in culture on the ordinary media. When strawberry leaves are inoculated from a pure culture they develop the typical leaf scorch.

[1] Examined by Miss Anna E. Jenkins, U. S. Dept. Agr. B. P. I.

OVER-WINTERING THE FUNGUS

When strawberry plants are mulched many of the leaves remain green over the winter. In these leaves the fungus winters over in the vegetative condition and produces abundant conidia in the spring. On some of the dry leaves the conidia remain in the acervuli. These conidia retain their vitality until the following spring. They germinate, in hanging drops, in about 6 hours, producing germ tubes from one or both cells of the spore.

On the dry leaves there is also produced an ascigerous stage. This stage occurs in abundance on the more exposed leaves. The earliest ascocarpus mature in late April and may be found until June. The perfect stage agrees well with descriptions and exsiccati specimens of *Mollisia earliana* (E. & E.) Sacc.

EVIDENCE OF THE RELATION OF MARSONIA POTENTILLAE AND MOLLISIA EARLIANA

Mollisia earliana is found on dry strawberry leaves following *Marsonia potentillae* and the conidia are often present on the leaves at the same time as the ascocarps.

RESULTS OF CULTURES FROM SINGLE ASCOSPORES

Cultures of the Marsonia stage were secured from single ascospores.

Date	No. of ascospores spores	No. of colonies	Spore form	Date
May 15, '19	15	10	Marsonia	May 29, '19
May 21, '19	10	7	Marsonia	June 4, '19
May 7, '20	15	14	Marsonia	May 21, '20

In all cases where the ascospores germinated a pure culture was obtained which produced spores of the Marsonia type. Strawberry plants were inoculated with a spore suspension obtained from some of these colonies. June 10, 1919, ten strawberry plants were inoculated by spraying with a spore suspension taken from the colonies obtained from a single ascospore planting made May 15, 1919. June 15, purplish spots were plainly seen. June 17, the spots were prominent, the centers becoming cinereous. June 21, the spots were typical of Marsonia. June 24 acervuli, bearing typical spores of *Marsonia potentillae* were present. Control plants remained free from disease.

May 26, 1920, five plants were inoculated with a spore suspension taken from the culture obtained from an ascospore planting made May 7. May 29, spots were evident. June 4, the spots were well

developed. June 9, fruiting, acervuli and spores typical of *Marsonia potentillae*. Control plants remained free.

June 16, 1920, ten plants were inoculated with a spore suspension taken from the same culture as that used on May 26. June 21, the spots were evident; June 26, spots extensive. July 1, typical acervuli and conidia of Marsonia. Control plants remained free from disease.

As the fungus causing leaf scorch or Mollisiose has not been adequately described the following description is appended.

(4) *Mollisia carliana* (E. & E.) Sacc. Syll. Fung. 8: 328
Peziza carliana E. & E. Bull. Tor. Bot. Club 1884, p. 74

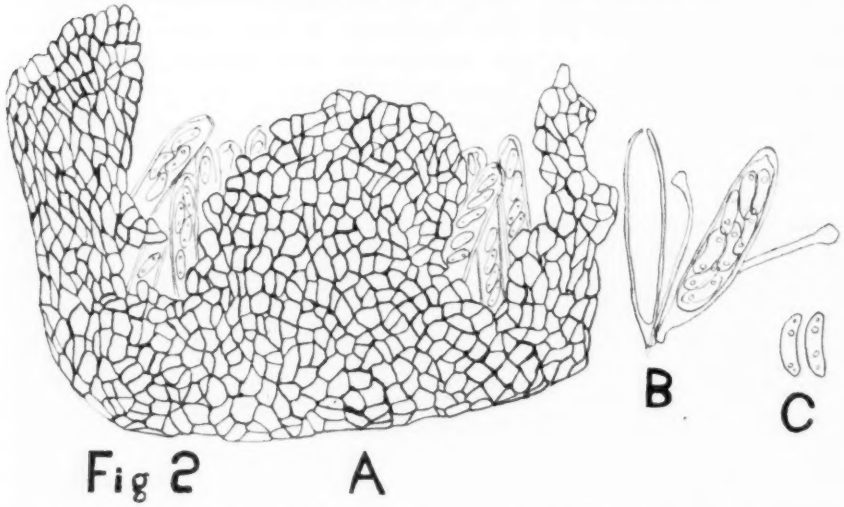


FIG. 2. A. Perithecium of *Mollisia carliana* (E. & E.) Sacc. showing the manner of dehiscence. B. Asci and paraphyses, one ascus empty showing the pore, the other containing spores and showing the slightly thickened apex. C. Typical ascospores.

(3) *Phyllosticta potentillae* Desm. Am. Sc. Nat. 8: 31
Leptothyrium dryadearm Desm.
Septoria potentillarum Fück.
Gloeosporium potentillae (Desm.) Oud. 26 Jarg. Ned 3, Beil p. 3
Marsonia potentillae (Desm.) Fisch. Rabenh F. Eur. 1857

(5) *Marsonia fragariae* Sacc. Malpighia 1896: 276.

(6) *Ascochyta fragariae* Auct.
Ascochyta colorata Auct.

ASCIGEROUS OR PERFECT STAGE

Apothecia hypophyllous superficial, brown to black, membranaceous, 0.25–1 mm. in diameter splitting open irregularly, margin irregular,

closing when dry and resembling a perithecium. Hymenium pinkish yellow. Asci 55–70 × 14–25 μ fasciculate, cylindrical, wall slightly thickened at the apex, opening by a pore. Ascospores hyaline, one-celled, 2–4 guttulate, elongated-elliptical, slightly curved, closely packed in the ascus, 18–28 × 3–6 μ. Paraphyses slender, capitate, non-septate, simple 50–60 × 3–3.5 μ; head 4–5 μ broad. (Fig. 2.)

On dry, overwintered leaves of cultivated strawberry, following *Marsonia potentillae* (Desm.) Fisch.

Collections—Guelph, Ont., May 14, 20, 22, 1920.
Guelph, Ont., Apr. 28, May 3, 8, 16, 26, 1920.

Original material collected by Earle in Illinois on Fragaria.

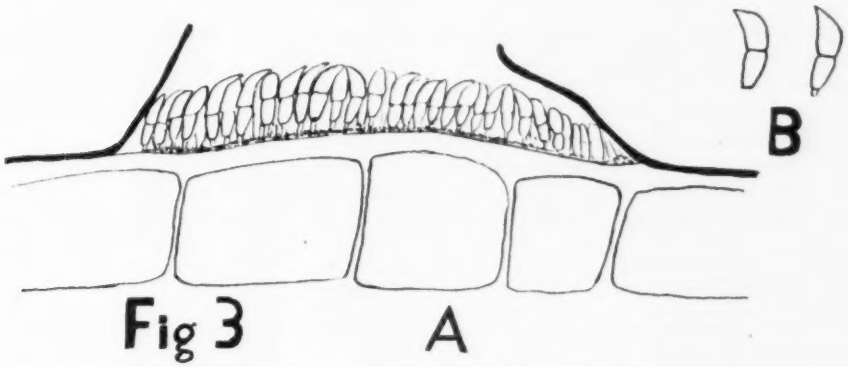


FIG. 3. A. Acervulus of *Mollisia earliana* (E. & E.) Sacc. (*Marsonia potentillae*) with conidia showing the sub-cuticular character. B. Typical conidia.

CONIDIAL STAGE

Spots at first purplish, irregular, later becoming cinereous in the center with a purplish margin, 4 to 12 mm. in diameter, becoming confluent and often involving entire leaves, also appearing as purplish streaks on petioles and peduncles. Badly diseased plants take on a dry scorched appearance.

Acervuli sub-cuticular, dark when dry, scattered over the cinereous portions of spots, glistening when moist; spore mass gelatinous, glistening, pink.

Conidia hyaline, two-celled, asymmetrical, upper cell larger, rostrate, 24–30 × 5–8μ, (Fig. 3).

Collections—Guelph, Ont., May 20, June 12, Sept. 8, and 29, 1919.
Guelph, Ont., Apr. 28, May 3, June 18, July 20, 1920.
London, Ont., Aug. 14, 1920. Waterford, Aug. 16, 1920.

Brantford, Aug. 18, 1920. Peterborough, Aug. 24, 1920. Ottawa, Aug. 28, 1920.

Guelph, Ont. May 1921, Burlington and Bronte and Port Nelson, June 13, 1921. Grimsby, St. Catharines, Jordan Harbor, June 16, 1921.

Also reported from Louisiana (Edgerton) Delaware (Cook), New Jersey (Cook) Connecticut (Clinton) Indiana (Jackson) (6) Illinois, (Anderson)[1] Europe (3), Siberia (5).

Control measures have not been worked out for this disease but it is reasonable to suppose that it can be checked by using the same measures used to control the leaf spot.

LITERATURE CITED

(1) STONE, R. E. Leaf scorch or mollisiose of the strawberry. (Abstracts) Phytopath. **11**: 44, 202-203. 1921.

(2) ——— The strawberry troubles of 1921. Canadian Horticulturist (Fruit Edition) **44**: 117. 1921.

(3) SACCARDO, P. A. Sylloge Fungorum **3**: 770. 1884.

(4) ——— Sylloge Fungorum **8**: 328. 1889.

(5) ——— Sylloge Fungorum **14**: 1021. 1899.

(6) United States Dept. Agric. Bur. Plant Ind. Plant Disease Bull. Suppl. **14**: 97. 1921.

[1] Specimen received.

THE LIFE HISTORY OF ROSELINIA CARYAE SP. NOV. CAUSING A HICKORY CANKER AND DISEASE

LEE BONAR

WITH THREE FIGURES IN THE TEXT

Early in the spring of 1921 Dr. C. H. Kauffman collected in some woods near Ann Arbor, Michigan, some twigs of *Carya ovata* which showed dead sunken areas on what were otherwise vigorously growing young shoots. An examination of this material by the writer showed these dead areas to contain the fruit bodies of a fungus. A survey of this wood lot, in which there are numerous saplings and young trees of

Fig. 1. Photograph of twigs showing cankers in varying stages of development.

Carya ovata showed a high percentage of the younger growth of this species, up to 4 inches in diameter, stump high, to be cankered to a greater or less degree.

The cankers on the young twigs are almost always around the leaf scars, or on the tips. (Fig. 1.) They are often quite distinct around each leaf scar, while in other cases they are confluent and the whole twig may be dead especially near the growing tip, where the killing is more extensive. As a rule the cankers are sunken areas, where the bark is still intact, and there is a raised margin in the formation of the healing lines about the border of the canker. The cankers are of varying sizes, from mere spots less than an inch in length, up to as much as 3 x 6 inches on some of the larger trunks. The cankers are, in practically all cases of greater extent up and down the twig than in a lateral direction, and except on very young twigs, seldom girdle the twig. Infection in small lateral twigs often extends to the main branch where it forms a dead sunken area about the point of union, but does not extend into the larger branch very far. The cankers on the larger limbs and on the trunks of these young trees are various in form. They were not observed on trunks more than 4 inches in diameter, stump high. As a rule the heavy bark is persistent over these sunken dead areas on the trunks, and when rather numerous they give the tree a gnarled and distorted appearance. One of these young trees presents, as a rule, a scraggly, irregular top, due to the fact that the leader has been killed, and sometimes the first lateral ones also. This combined with a gnarled trunk, in extreme cases, gives a very scrubby young tree. A few cases were seen where very much gnarled saplings 2 to 3 inches in diameter had died back to the ground. In such cases a whorl of sprouts had come up about the dead trunk, and these showed numerous small infections on the tips and at the leaf scars. Some of these sprouts 5 years old produced new leaders and presented the typical scrubby appearance.

THE FUNGUS AND THE HOST

Examination of the cankers on the younger twigs invariably showed abundant fruiting bodies of a fungus in the bark. They are formed just beneath the periderm, and break through singly as small pustules. No fruit bodies of the fungus were found in the cankers on the trunks, in the very hard heavy bark. These cankers on the trunks were in all cases, however, associated with an abundance of twig infection with the fruit bodies of the fungus present, so that there seems no doubt that they are of the same origin. These fungous fruit bodies prove to be pycnidial structures, somewhat variable in form, growing just beneath

the periderm which then breaks and shows a black dome beneath. In section one sees a black differentiated wall over the top only (Fig. 2e). Subsequent growth, however, tends to form a more definite pycnidial structure as the black wall develops downward all the way around except a narrow portion at the base. (Fig. 2f.)

There is no definite ostiole, but the hymenial layer extends over the entire inner surface of the pycnidium. Hyaline spores are borne in great abundance on the short conidiophores which are shaped like Indian clubs, (Fig. 2g) and are continuous around the entire interior of the fruit body. These spores are broadly fusoid, usually containing oil globules, and are 5 to 7 × 2.5 to 3 μ in size. At maturity the pycnidium bursts open in an irregular manner. Sometimes the spores emerge through an irregular split, more often, however, the whole upper carbonaceous part breaks away as a lid leaving a cuplike structure.

Fig. 2. e–young pycnidium, f–mature pycnidium, g–conidiophores and spores, h–pycnidiospores.

Single spore isolations were made from this fungus, and it was found to grow readily in culture. It fruits abundantly on sterilized green bean pods, or green bean agar, but not on corn meal or sugar-peptone agar. Pycnidia formed in artificial culture are found to have a pycnidial wall all the way around, and in some cases there is a slight papilla like growth similar to an ostiole, although no opening has ever been observed. Clean hickory twigs in test tubes, were sterilized and inoculated with a pure culture of the fungus. They became covered with an abundant growth of mycelium and pycnidia formed in the mycelial growth.

THE ASCUS STAGE

Young twigs, normally infected, were brought in from the woods, and sterilized on the outside by soaking in a 1–1000 solution of mercuric

chloride for 5 minutes. After this they were washed very carefully in large test tubes containing sterile water, through two washings, and then placed in sterile tubes containing a small amount of sterile water. After 6 months numerous fruit bodies were found developing on the bark of one of these twigs. Examination showed these to be perithecia bearing mature ascospores in abundance (Fig. 3, a–c.) Single spore isolations were made from these ascospores, and the resulting cultures gave a pycnidia forming fungus corresponding morphologically and culturally with the fungus isolated from the cankers of the twigs.

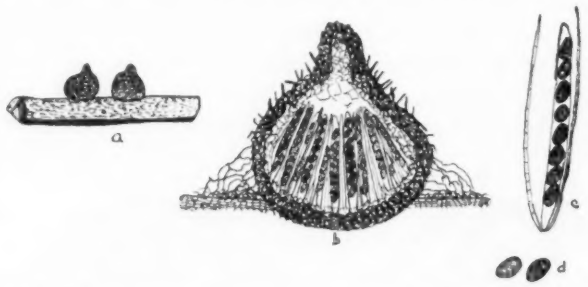


Fig. 3. a–habit of the perthecium on the wood, b–median section through perithecium, c–ascus and paraphyses, d–ascospores.

IDENTITY OF THE FUNGUS

The ascus stage of this fungus falls into the genus Rosellinia. As this species appears to be undescribed in the literature, the name *Rosellinia caryae* sp. nov. is proposed for it. The taxonomic position of the imperfect stage of this fungus is not so easily determined because of the variance of the opinion of different writers on the general group to which it belongs. It falls in the genus Dothichiza Sacc. (4), in the sense of Diedecke (1). Diedecke, in his treatment of the subject, thinks that this genus should be placed in the Sphaeropsidales, but hesitates to do so because of the dearth of information concerning many species of the genus Dothichiza (3). The form in hand comes very close to the genus Phomopsis in the sense of Diedecke and Von Höhnel, as Diedecke (2) says is true of all the known species of the genus Dothichiza. The principal argument against connecting this form with the genus Phomopsis is that, in all the known cases, the ascus stage of the species of Phomopsis belongs to the genus Diaporthe.

TECHNICAL DESCRIPTION

Rosellinia caryae sp. nov. Perithecia superficial or slightly sunken in the outer bark, scattered or gregarious, carbonaceous, brittle, slightly

bristly in some cases, otherwise smooth, broadly flask-shaped, with a short distinct ostiole. Asci cylindric, 8-spored, averaging 50 × 6–8 μ. Spores uniseriate, sub-globose, one-celled dark brown, 5–7 × 3.5–4.5 μ. Paraphyses tenuous filiform.

IMPERFECT STAGE

Dothichiza caryae sp. nov. Pycnidia scattered, erumpent, dome-shaped, non-ostiolate, irregularly dehiscent, wall distinct except at the base, hymenial layer continuous over the inner surface, conidiophores short, Indian club shaped, spores 1-celled, hyaline, broadly fusoid, 5–7 × 2.5–3 μ.

SUMMARY

1. An undescribed canker and disease is found on young trees of *Carya ovata*.

2. Cankered areas are most abundant on the smaller limbs and twigs, but are sometimes found on the trunks of saplings.

3. A pycnidium forming fungus is constantly associated with the cankers on the twigs.

4. The ascus stage of this fungus was developed on hickory twigs in the laboratory, and cultures made from single ascospores correspond identically with cultures made from the pycnidial forms on the twigs.

5. The name *Rosellinia caryae* sp. nov. is proposed for this fungus, the pycnidial stage of which belongs to the genus Dothichiza.

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LITERATURE CITED

(1) DIEDECKE, H. PILZE. Kryptogamenflora der Mark Brandenburg **9**: 746. 1914.
(2) ———— Die gattung Phomopsis. Ann. Mycolog. **9**: 8–35. *Pl. 1–3.* 1911.
(3) HEDGCOCK, G. G. AND N. R. HUNT. Dothichiza populea in the United States. Mycologia **8**: 300–308. *Pl. 194, 195.* 1916. Literature cited, p. 308.
(4) SACCARDO, P. A. Dothichiza. Syll. Fungorum **3**: 671. 1884.

LIGHTNING INJURY TO HEVEA BRASILIENSIS

CARL D. LA RUE

Rutgers[1] has compared the effect of lightning on Hevea trees with that caused by the same agent on various trees in Europe and has discussed in some detail four types of injury. These four types may be summarized as follows:

1. In this case single trees or groups of trees are killed, while the surrounding trees may show injury resembling the so-called "die-back."

2. This type of injury manifests itself as a rather long, vertical split in the bark.

3. A number of small wounds characterize this type of damage. These wounds resemble those caused by severe hail storms. They are usually in the upper part of the tree and when the exuded latex turns dark they become very conspicuous.

4. This type of injury consists in the killing of the outer layers of the bark which then slough off giving the tree a scurfy appearance.

The writer has little to add to Rutgers' description of the last three types of injury but certain phases of the first type have come under his observation which have not yet been described.

Rutgers reports that only on one occasion has he seen young trees killed by lightning. The writer, however, has seen a number of cases of this sort in trees from one to three years old. Attention is usually attracted to the injured trees by the wilting of the leaves about a foot from the tip of the stem while those above and below this point are still normal. Examination shows that the bark of the twigs bearing the withered leaves is dead and black. The cambium of the regions immediately above and below the dead bark is discolored, generally showing a purple hue, while the cortex still appears green and normal. The discoloration of the cambium progresses upward to the tip of the stem and downward to the root and in a few days the tree is dead.

By the time this stage is reached, (frequently before the injury is noticed) the part of the bark which first showed injury is covered with Diplodia spores and often the case is diagnosed as "Diplodia die-back."

Frequently a number of trees are killed in one spot, although sometimes only one, and a number of neighboring trees are injured only to the extent of losing a foot or two of the tips of their stems by "die-back."

[1] Rutgers, A. A. L. Bliksemschade bij Hevea. Archief voor de Rubbercultuur in Nederlandsch-Indie. **3**: 163–170. *17 fig.* 1919.

If seen in its early stages the injury can be easily diagnosed by the purple discoloration of the cambium, and by the curious fact that the tip of the stem almost always (always in the writer's experience) appears entirely normal while the bark just below is dead. Perhaps the denser rosette of leaves at the tip in some way protects the stem at that point.

The same type of injury in mature trees had become familiar to the author before it was observed in young plantations. In the first case lightning was not at first suspected as being the cause. The tree most affected had one branch in its top which was dead with all its leaves withered. All of the bark of this branch was dead, and from the point where the branch joined the trunk to within 3 feet of the root crown, all the bark of the trunk was dead.

The limits of the diseased bark were determined as accurately as possible. Beyond the totally dead bark an area of sound bark was found which overlaid discolored cambium. The cambium under the dead bark was black; that underlying the apparently sound bark was of a deep purple color which became fainter and fainter until it finally disappeared entirely as the limit of the injured area was reached.

The adjacent trees were examined and it was found that most of the branches nearest the dead branch of the first tree were affected. A few leaves just back of the tip of one twig of each of these branches were wilted and dead. The leaves at the tip were usually normal or just beginning to wilt. The bark of the region bearing the wilted leaves was found to be black and dead while beyond this region the cambium showed the purple discoloration for a distance of about 2 feet. The remainder of each of these trees was entirely normal. It looked very much as though an infection was spreading from the diseased branch on the first tree to all the surrounding trees.

Two days later the trees were again examined. All the bark which showed injury at the time of the first examination was now dead and in many places it was covered with Diplodia spores. The cambium under the dead bark was full of black mycelium resembling that of Diplodia and the vessels of the wood beneath for a depth of 1 or 2 mm. were filled with mycelium making them appear as black lines.

In the tree first observed the damage had extended throughout the bark of all of the branches, of the trunk, and of the main roots. The cambium layer showed the purple color already described and had a strong, sour smell much like that caused by Sphaerostilbe infection.

In the less severely affected trees it was found that the discoloration of the cambium had progressed downward from the twigs; in some cases for only 3 or 4 feet, in other cases to the ground level.

Bits of tissue from the diseased areas, and of sound tissue bounding the diseased areas, were allowed to develop in agar tubes. These cultures included cambium, wood and bark, from twigs, trunks, and roots. Almost without exception these cultures developed growths of *Diplodia cacaoicola*, with which in a few cases *Gloeosporium alborubrum* and other common parasites were associated.

However, knowing that almost any tissue, cut from apparently healthy Hevea trees, will develop Diplodia mycelium and spores as it dies, the author was unwilling to accept the evidence of the cultures and to believe that Diplodia was able to produce such rapid and destructive effects. A few days later the wire cup hanger on the trunk of a tree showing similar injury was found to have been melted by lightning, and the clue given by this was followed until conclusive evidence was secured.

It is very likely that it was the absence of any indication of the action of lightning, together with the development of Diplodia on injured trees in the field, and in cultures of diseased tissues which led Petch[1] to suspect that Diplodia was the cause of the death of such trees. He believed that the organism concerned was an extremely virulent species of Diplodia, which he named *Diplodia rapax*. From the evidence given above there can be little doubt that the trees described by Petch were killed by lightning.

The spread of the discoloration in the cambium and bark is curious and closely resembles the progress of an infection. It appears that the path of the lightning is not on the surface of the tree, as it usually appears to be in injuries to trees in Europe and America, but through the cambium. This tissue seems to offer the best path for the conduction of electricity However, it may be that the current passes mainly through the water in the vessels of the sap-wood and that the wood does not readily show the injury. The cambium which lies nearer the sap-wood than does the phloem or the cortex shows evidence of derangement earlier than either.

The region which carries the heavier part of the current is likely killed at once; the cells which carry a weaker current die more slowly and this gives an apparent effect of a spreading infection. Since a branch has a smaller cross section area for the current it carries than has the trunk of the tree, the branch dies near the tip first and the death of the tissues progresses downward to the roots. In many cases the current is ap-

[1] Petch, T. The physiology and diseases of *Hevea brasiliensis*, Dulau & Co. Ltd London, p. 1–268. Pl. 1–15. 1911.

parently only strong enough to kill the twigs or smaller branches, while the trunks and larger branches are not noticeably injured.

At the time the trees described were found some 30 trees were seen within an area of about one-tenth of a square mile which were all either killed or severely injured by the same electric storm. These injured trees were in groups of 5 or 6. Similar groups of damaged trees were reported in several other areas in the vicinity. The exact nature of the discharges causing the damage is not known but it is probably not the noisy type of discharge common in America, as thunder storms are very rare in Sumatra. It is more likely some form of silent discharge, though silent discharges are usually considered harmless.

The purple color developed in the cambium which has been killed by lightning has already been sufficiently emphasized. This is of value in diagnosing lightning injury in Hevea trees as it is very rarely developed in cambium killed by other agents. This color often extends outward into the bark nearly to the cork.

After the bark is dead it is markedly different from bark killed in other ways. The bark of Hevea is always full of stone cells, and in bark killed by lightning all of the other cells disintegrate within a remarkably short time leaving nothing but the stone cells with the strands of rubber which have coagulated in the latex vessels. The nature of the bark is a sufficient indication of lightning injury in cases where it is too late to detect the characteristic discoloration.

Without doubt a great many cases of "die-back" in the tops of Hevea trees are due to lightning but are erroneously attributed to Diplodia or some other organism.

Rutgers states that he has never seen branches or strips of wood and bark torn from Hevea trees by lightning. The writer has observed three cases of this type of injury but it is extremely rare.

SUMMARY

Trees of *Hevea brasiliensis* are frequently injured or killed by lightning. Such cases of injury are usually wrongly diagnosed. Both young and old trees may be affected. In some cases a differential rate of death of the injured tissues closely simulates the effects from the invasion of the tissues by a destructive organism. Splintering or shattering of trunks or branches by lightning is extremely rare in rubber trees.

THE EFFECT OF LACTIC ACID ON SPORE PRODUCTION BY COLLETOTRICHUM LINDEMUTHIANUM[1]

E. F. Hopkins

With Two Figures in the Text

It has been the experience of the writer in using *Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. and Cav. in class work that the organism does not sporulate readily on potato dextrose agar. Barrus (1, 2) states that it sporulates readily on bean plugs or in culture media at 21° C. when the cultures are "in good spore producing condition," but in carrying a culture of the B strain of this species for over a year on potato agar in this laboratory with frequent transfers no macroscopic pustules of conidia were formed, although the same culture fruited abundantly on bean plugs. At the same time cultures of two other anthracnose organisms, *Colletotrichum trifolii* Bain, and *Gleosporium musarum* C. & M. fruited abundantly on this medium. In the case of *Colletotrichum pisi* Pat., Jones and Vaughan state that this species does not fruit readily on common media.

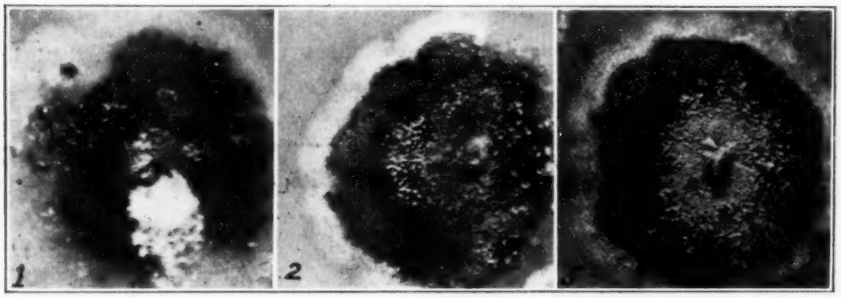

Fig. 1. Lactic acid and spore production in *Colletotrichum lindemuthianum:* 1, 2, and 3 drops of lactic acid respectively per 20 cc. of potato agar.

A preliminary experiment was carried out to determine the effect of lactic acid on sore production in this species. Transfers were made to ordinary potato agar and to potato agar containing 1, 2, and 3 drops of 50 per cent lactic acid (approximately 7 N) per 20 cc. of the medium. On the eighth day after planting the cultures, abundant sporulation could be observed macroscopically in the culture to which 3 drops of acid were added. This showed as a pink slimy layer about 1 cm. in diameter while the colony was about 1.7 cm. in diameter. In the cul-

[1] Published by permission of the Director of the Missouri Experiment Station.

ture containing 2 drops of acid a few pustules were observed while in the one with one drop no sporulation was visible to the naked eye although some conidia were found by making a microscopic examination. The appearance of the fungus on agar to which no acid had been added was similar to the last.

In figure 1 the cultures containing 1, 2, and 3 drops of acid are shown. These were photographed several days after the above notes were taken. By this time the culture with 2 drops of acid had sporulated to a somewhat greater extent than before, but the one with one drop showed no macroscopic evidence of sporulation even after being kept for some time. The whole surface of the culture to which no acid had been added was scraped off and mounted in liquid for microscopic examination. Only a few spores were found in the entire mount. The spores formed in the most acid plate were normal in shape and size.

After this same procedure was used successfully by students in obtaining abundant fruiting in petri dish cultures, the experiment was repeated. At the end of 8 days abundant sporulation was noted in the most acid culture and none in the others. At the end of 10 days there were a few pustules in the culture containing two drops of acid. In order to estimate the number of spores produced in these cultures after 10 days of growth the diameters of the colonies were recorded and direct counts of the spores were made. To accomplish this suspensions of the spores were made from each plate by pouring a few cubic centimeters of a weak solution of para cresol over the colony and the spores loosened by gently rubbing the surface of the culture with a scalpel. The spore suspension thus formed was poured through a funnel into a graduated cylinder and the surface of the plate washed carefully with more of the cresol solution until the volume amounted to 20 cc. The purpose of the cresol was to prevent germination and contamination while making the counts. The spore suspensions showed increasing turbidity from the least acid, which was practically clear, to the most acid culture which was very turbid.

After shaking the spore suspensions thoroughly counts were made in a haemocytometer. It was found advisable to count all the spores found in the nine square millimeter area of each cell except in the case of the most acid culture in which case 8 of the smaller squares in the cell were counted and averaged and the total number for the counting chamber calculated. The volume of each of the two cells was 1.68 cu. mm. From the counts made in this manner the total number of spores in the 20 cc. of spore suspension was estimated and by dividing by the area of the colony in square centimeters the results were reduced to

comparative basis. The data are summarized in table 1. The pH values given were not determined but are approximate and are taken from a titration curve for potato dextrose agar recently presented by the writer (4).

TABLE 1

Effect of lactic acid on spore production by Colletotrichum lindemuthianum

Drops of 50 per cent lactic acid	pH approximate	Diameter of colonies in mm.	Spore Count			Total number of conidia	Conidia per sq. cm. of colony
			I	II	Average		
0	7.4	33	0	6	3	35,714	4,176
1	4.5	40	174	181	177.5	2,113,100	168,200
2	4.0	37	244	265	254.5	3,029,800	281,800
3	3.8	28	4262	3960	4111	48,941,000	7,947,000

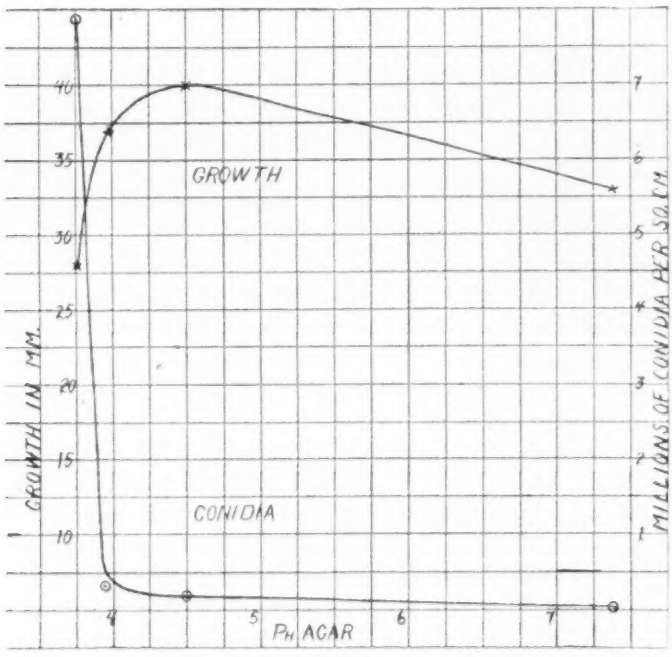

FIG. 2. Lactic acid and spore production in *Colletotrichum lindemuthianum:* graphical representation of growth and of conidia per sq. cm. of colony surface.

The errors are multiplied to a large extent but the comparative difference is easily seen. This is brought out more clearly in figure 2. Spore production in this instance increases gradually with increasing initial hydrogen-ion concentration from about pH 7.4 to about 4.0 and then takes a sudden jump at 3.8. It is noteworthy that with this great increase in spore production the increased acidity does not greatly inhibit the amount of growth. The growth in diameter in the most acid culture is 0.7 of that of the largest colony in the series. Spore production in this species therefore, appears to increase with increase in hydrogen-ion concentration and with the accompanying decrease in the amount of growth.

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LITERATURE CITED

(1) BARRUS, M. F. Bean anthracnose. New York (Cornell) Agric. Exp. Sta. Mem. **42**: 97–209. *20 fig., pl. 1–8 (5 colored).* 1921. Bibliography, p. 199–209.

(2) BARRUS, M. F. Varietal susceptibility of beans to strains of *Colletotrichum lindemuthianum* (Sacc. & Magn.) B. & C. Phytopath. **8**: 589–614. *Pl. 1–5.* 1918.

(3) JONES, F. R. AND R. E. VAUGHAN. Anthracnose of the garden pea. Phytopath. **11**: 500–503. *2 fig., pl. XXV.* 1921.

(4) HOPKINS, E. F. Note on the hydrogen-ion concentration of potato dextrose agar and a titration curve of this medium with lactic acid. Phytopath. **11**: 491–494. *1 fig.* 1921.

ON THE OCCURRENCE OF MYCOSPHAERELLA WILT OF MUSKMELONS IN JAPAN

TAKEWO HEMMI

The wilt caused by *Mycosphaerella citrullina* (Smith) Gross. is a well-known disease which is occasionally destructive to greenhouse muskmelons and to watermelons in America. Until 1919 the writer had never heard of the outbreak of this disease in Japan. August 19, 1919, Dr. Hoshino, Professor of Horticulture of Kokkaido Imperial University at Sapporo, called the attention of the writer to the outbreak of an uncommon disease which was causing injury to the muskmelons being grown in the greenhouse of the Department of Horticulture (3). The writer visited the greenhouse and found several plants attacked by a disease which was quite new to him. The diseased plants were as green as the healthy plants in general appearance, but several of their lower nodes were pale-green in color with or without gum exudation. Some of the diseased areas had reached a more advanced stage, being dry and blackish or grayish in color. On such dried areas the writer found abundant minute black points which proved to be the pycnidia or the perithecia of a kind of fungus. In this case the cross-section of the vine at the diseased region showed discoloration only at the outer portion of the primary cortex and therefore indicated the disease to be in the early stage of its development. Subsequently the writer visited the greenhouse several times and learned that the disease had spread very rapidly, causing the wilt of leaves and vines, and occasionally becoming so severe as to result in the complete ruin of the plant. At that time the infected areas could be seen also at the upper portion of the vine, but most of these infections, having originated in the crotch of a branch or in the axil of the leaf, were confined to the vicinity of the nodes. Although the writer was out of the city in the summer of 1920, he was informed that the disease had reappeared in the same greenhouse and had also broken out in the greenhouse of the botanical garden belonging to the same university.

The symptoms of the disease are shown first as pale-green and irregular-shaped patches around the nodes. The diseased areas rapidly extend some distance above and below these infected nodes and soon a reddish brown gum exudes from several points on these areas. The areas gradually become gray or blackish gray and the exuded gum dries and sometimes turns blackish-brown. Owing to the abundant development of

the pycnidia and also of the perithecia of the causal fungus, the diseased vine in the advanced stage often appears black. The diseased regions extend sometimes to the leafblades through the petioles, showing discoloration and minute black points on the upper surface and also on the petioles. The diseased areas on the leaf are generally large and irregular in shape, light brown or grayish brown in color, and indistinct in demarkation. The diseased leaves gradually shrink, turn yellow, and finally shrivel up. The careful observations of the symptoms as well as the microscopical studies of the fungus developed on the vines led the writer to recognize the disease to be the same as the so-called "Mycosphaerella Wilt" described by Grossenbacher (2) in 1909.

In the fall of 1890 the watermelon vines cultivated on a field in the eastern United States were attacked by a severe disease and the causal fungus was recognized by Chester to be a species belonging to the genus *Phyllosticta*. He examined a similar disease in 1892 and found again the same fungus, and also an ascigerous fungus side by side with it in the same spots which he thought was a species of *Sphaerella* (1). In 1905 Smith (7) reported that during the autumn of 1903 he had found the same fungus most abundantly on the leaves and the fruits of squash and pumpkin and also to a limited extent on the leaves of cucumber and cantaloupe. He changed the genus name of this fungus and called it *Ascochyta citrullina* (Chester) Smith in its pycnidial stage, using the name *Sphaerella citrullina* Smith for the perfect stage. According to Grossenbacher the fungus on several of the cucurbits reported by Chester and Smith is nothing but the causal fungus of the wilt of greenhouse muskmelon under consideration. It was in 1907 and 1908 that the fungus attacked severely the muskmelons grown in one of the greenhouses of the New York Agricultural Experiment Station, where Grossenbacher found opportunities to study the disease. In the early summer of 1909 Massee (4, 5) in England several times received the diseased stems of tomato, on which he found also the same fungus. So far as the writer knows, this is the only report of the fungus attacking other plant besides cucurbits. Soon after that some cucumber vines attacked by the same fungus, were received. By inoculation experiments it was proved that the fungus on cucumbers affects tomato seedlings and that the fungus on tomatoes affects pumpkin seedlings. According to Grossenbacher, however, cucumbers are immune to the disease; consequently the writer was interested to investigate further the pathogenicity of the fungus to cucumbers. At the last meeting of the American Phytopathological Society at Toronto in December 1921 Meier, Drechsler and Eddy (6) presented a paper on the cucumber black rot caused by

the fungus. They found the disease on cucumbers shipped from Florida on their arrival at the New York market. Although the pathogenicity of the fungus to cucumber vines is still unknown, their discovery of the fungus on the fruit is important.[1]

By microscopical examinations the writer recognized the morphological characters of the fungus found in Japan to be quite identical with those described by Grossenbacher and several other authors. The pycnidia and also the perithecia develop first in the tissue and elevate the epidermis, but soon they perforate it and appear on the surface. The pycnidia measure about 82 to 164 μ in diameter. The pycnospores are hyaline, mostly two-celled, 7 to 20 by 3 to 6 μ in size and more or less constricted at the septa. The cells in these two-celled spores are sometimes unequal in size. The spores seem to vary considerably in size and also in shape. Mixed with the predominating two-celled spores the writer also found one-celled, three-celled, or four-celled spores. The shape of the spores is generally more or less cylindrical, ovoid, or clavate, mostly with rounded and sometimes with tapering ends. This pycnidial stage is called *Ascochyta citullina* (Chester) Smith or *Diplodina citrullina* (Smith) Gross. The perithecia measure about 80 to 160 μ in diameter, and in their vigorous condition often become almost wholly superficial. The asci are 44 to 56 by 7 to 11 μ, cylindrical or clavate-cylindrical, and aparaphysate. The ascospores are hyaline, two-celled, generally constricted at the septum and 9 to 13 by 4 to 5 μ in size. They are subfusoid with subovoid cells, and the distal cells are generally wider than the others. From the morphological characters in the perfect stage, the writer easily recognized the fungus to be a species of *Mycosphaerella* and therefore the name given by Grossenbacher, *Mycosphaerella citrullina* (Smith) Gross., must be used in the future references.

As a control measure the spraying with Bordeaux mixture is recommended in the literature, but the use of this measure soon after we had found the disease in the greenhouse was not successful, probably owing to the fact that the infections had already taken place before that time.

[1] Soon after the manuscript had been prepared, the writer, who was then staying in the United States, received an interesting letter from Mr. Kikujii Kuwatsuka, Plant Pathologist of the Shizuoka Agricultural Experiment Station in Japan. He informed the writer that he had received diseased vines and leaves of the cucumber and of a kind of gourd (*Lagenaria vulgaris* Ser. var. *gourda* Ser.) from Mihomura in the Shizuolka Prefecture and had found on them the fungus, *Mycosphaerella citrullina* (Smith) Gross. The writer has had no opportunity to examine the specimens himself, but this report of the discovery of the fungus on cucumber vines and leaves seems to him to be a valuable contribution to the knowledge of its pathogenicity.

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LITERATURE CITED

(1) CHESTER, F. D. Report of the mycologist, Delaware Agr. Exp. Sta. Ann. Rept. **5:** (1892–1893) 53–80. 1893.

(2) GROSSENBACHER, J. G. A Mycosphaerella wilt of melons. New York [Geneva] Agr. Exp. Sta. Technical Bul. 9, p. 193–229, *6 pl.*. 1909.

(3) HEMMI, T. Mycosphaerella wilt of muskmelons. By ochu Gai Zasshi (Jour. of Plant Protection) v. 7, no. 1. 1920. (In Japanese).

(4) MASSE, GEORGE. Diseases of cultivated plants and trees. *602 p., 171 fig.* 1910.

(5) ———— Cucumber and tomato canker (*Mycosphaerella citrullina* Gross.). Board of Agric. [London] Leaflet No. 230. 1910.

(6) MEIER, F. C., CHARLES DRECHSLER, and E. D. EDDY. Cucumber black rot caused by *Mycosphaerella citrullina*. Phytopathology [Abstract] **12:** 43. 1922.

(7) SMITH, C. O. The study of the diseases of some truck crops. Delaware Agr. Exp. Sta. Bul. 70, *16 p., 2 pl., 6 fig.* 1905.

PHYTOPATHOLOGICAL NOTES

Occurrence of Thielaviopsis paradoxa on the cocoanut palm in Florida.—In January, 1922, sections of a diseased trunk of cocoanut palm (*Cocos nucifera*) from Cocoanut Grove, Dade County, Florida, were submitted to the Office of Fruit Disease Investigations through the courtesy of Messrs. G. F. Moznette of the U. S. Bureau of Entomology, and Edward Simmonds, of the U. S. Bureau of Plant Industry. The specimens showed extensive rotting of the ground tissue of the mature parts of the trunk, resulting in internal cavities of considerable extent. Trunk bleeding was reported not to have occurred in the standing tree, which was the only one affected out of a small ornamental planting. The disintegrated tissue when seen by the writer was dry and brittle. Surrounding this was a zone of recently invaded tissue which was brown and water-soaked. Cultures from the advancing margins of the decaying areas, made from tissue removed with aseptic precautions, yielded practically pure cultures of a fungus which agrees closely with published descriptions of *Thielaviopsis paradoxa* (De Seyn.) V. Höhn. To further confirm the identity of the fungus, two firm pineapple fruits from the market were inoculated from pure cultures of the fungus at a number of points through punctures, and a similar number of uninoculated check punctures were made on other portions of these fruits as well as on a third uninoculated fruit. Typical Thielaviopsis pineapple rot developed promptly at all the inoculated punctures and no rot developed at the check punctures. A greenhouse plant of Red Spanish pineapple was successfully infected through leaf punctures. *Thieavilopsis paradoxa* was readily recovered in pure culture from the artificially infected pineapple fruits and leaves.

The rate of growth of the fungus was observed in a preliminary series in corn meal agar cultures at maintained temperatures of 10, 15, 20, 25 and 30° C., sowings being made from microspores.

Macrospore formation gave a dense black appearance in two days to the culture at 30° C. A similar appearance was reached in three days at 25° C., and in four days at 20° C. At 15° C. the first sporulation was observed in five days and it did not reach the dense black stage for ten days. Mycelial growth seemed about equally rapid for the first three days at 30° and at 25° C. On the fifth day the 25° C. culture was distinctly in the lead; by the seventh day it had been equaled by the slower

growing culture at 20° C., both of these then exceeding the cultures at 30° C. and at 15° C. By the tenth day the culture at 15° C. had caught up with the one at 30° C. in extent of mycelium growth, both of these being then somewhat behind the cultures at 25 and at 20° C. No mycelium growth was evident during 12 days at 10° C. The indications are that around 25° C. is the best temperature for mycelium development of the fungus. Five degrees above this there seems to be about the same rapidity of development for a short time, followed by a slowing of rate of increase. Five degrees below this assumed optimum growth is somewhat slower, but eventually an equal maximum development is attained. At 15° C. there is very distinct retardation, and a 10° C. visible development does not occur during a twelve-day period. —H. R. FULTON.

Photographing tube cultures.—In the literature of plant pathology and bacteriology one frequently sees photographs of cultures that are of little value for scientific purposes because of the "high-lights," or streaks of reflected light, on the sides of the tubes. Light striking this curved surface is reflected in all directions; and a reflection shows in the picture for each source of light. Some rather complicated methods have been described for the prevention of these objectionable features; but they can be avoided with the ordinary photographic equipment by a little care in placing the tube. For those who have not already solved the problem the following may be useful:

(1) *Use light from only one direction.* With natural light it is best to use only one window. (2) *Place the tube so that its long axis lies within the plane formed by the tube, the source of light and the camera;* only light reflected in this plane can now show in the photograph. This reduces the reflecting surface of the tube, so far as the picture is concerned from a curved mirror to a flat one. If the tube is perpendicular to the camera, as it should be to obtain proper perspective, no streaks of light will now show unless the angle, light to culture tube to camera, is very acute. Widen this angle if necessary by tilting the camera and tube, or by moving the camera and tube farther from the window, or if using artificial light by moving the light.—WALTER N. EZEKIEL.

Variation in color of pear blight exudate.—While carrying out an experiment with pear blight, a peculiarity in color of the exudate was observed. Several loquat trees, (*Eriobotrya japonica* Lind.) were inoculated with a pure culture of *Bacillus amylovorus,* (Burrill) De T., in bouillon by means of the hypodermic needle, March 20, 1921. These inoculations were made in the growing tips of young trees in the green-

house. Five days after the inoculation beads of exudate appeared. The exudate was mostly of the characteristic colors. However, on one twig there were several good sized beads of a dark green color, not compared with a color chart but approximating Ridgway's Meadow Green. The color did not fade nor change with standing. On examination it was found that the green exudate was filled with bacteria which agreed with the pure culture of *B. amylovorus* as to staining reactions and general morphology. Later this particular twig showed the characteristic wilt and blight the same as shown by twigs producing the usual form of exudate. The later beads did not show the green color.

It is evident that the green exudate is very rare as no note of its occurence has been found in literature.—J. P. MARTIN, Laboratory of Plant Pathology, University of California, Berkeley, Cal.

Personals: Dr. R. D. Rands, for the past three years engaged in rubber disease research for the Dutch government at Buitenzorg, Java, has recently returned to this country and accepted an appointment as pathologist in the Office of Cotton, Truck, and Forage Crop Disease Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. Doctor Rands will take charge of the Department's work on diseases of beans, with headquarters in Washington.

During the summer Messrs. C. O. Peak, O. A. Plunkett, C. L. Porter and P. A. Young will be employed in Plant Disease Survey work in the State of Illinois. This survey is under the general direction of F. L. Stevens and under the special direction of Mr. L. R. Tehon.

Dr. A. G. Johnson, Associate Professor of Plant Pathology, University of Wisconsin, and Pathologist, Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, formerly stationed at Madison, Wisconsin, has transferred headquarters to Washington, D. C., where he will continue his work in the Office of Cereal Investigations. He has resigned his University appointment.

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